high ultraviolet transmission is desired for therapeutic purposes. Although these glasses are fairly stable to ordinary sunlight, their ultraviolet transmission is greatly reduced by exposure to strong sources of radiation in the region below 300 mμ.

The glasses whose cut-off occurs at a longer wave length than spectacle crown are used primarily for spectacles to protect the eyes from the injurious effects of ultraviolet radiation. The smoke is a nearly neutral glass except for transmission bands in the red and deep violet, but its ultraviolet cut-off is not far from that of spectacle crown. It is made in several shades and is most useful where a moderate absorption throughout the visible region is required. The Crookes glass is one of a series developed by Sir William Crookes as a protection against injurious radiations in both the ultraviolet and the infrared. It has a high absorption in the near ultraviolet, which is due to oxides of cerium, but it also has a slightly smoky appearance because of the two strong absorption bands in the yellow due to didymium. The didymium is not an essential constituent, however, and recently the glass has been modified so that it is quite colorless and can scarcely be distinguished visually from ordinary spectacle crown. Where a slightly yellowish color is not objectionable, Noviol glass furnishes a very effective protection against the ultraviolet. The transmission curve of only the lightest shade is given in the figure but the glass is available in darker shades. Amber glass is effective in absorbing the ultraviolet but it absorbs in the visible region to a considerable extent also.

It is of interest to note that clear gelatin in the thickness used for Wratten filters has a cut-off in the ultraviolet similar to that of Vitaglass. Also, the Wratten No. 2 filter, which is dyed with aesculin, has a transmission very similar to that of Noviol O, whose curve is shown in Fig. 194.

The transmission curves of the optical materials that are most widely used in the infrared are shown in Fig. 195. Following the usual custom, the curves are for a thickness of 1 cm, a curve for spectacle crown of 2-mm thickness, as it is commonly used in spectacles, being added for comparison. Because the infrared region was formerly regarded as the seat of heat radiation, substances that are transparent in this region are sometimes said to be *diathermanous*. Most of them are also transparent to the ultraviolet, fluorite being useful to 120 mμ, quartz to 185 mμ, and calcite to 215 mμ. These substances are used so

frequently for optical purposes that they will be described in greater detail in the following section.

Materials that are opaque to the infrared but transparent in the visible region are said to be *heat absorbing*. They are used

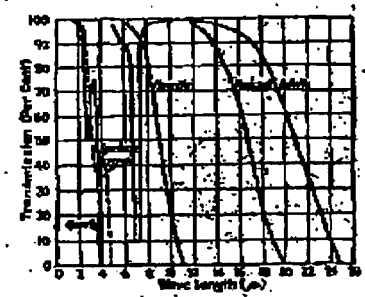

FIG. 195.—Infrared transmission of certain optical materials (corrected for surface reflection). The curve for spectacle crown is for a thickness of 2 mm. (*Bur. Standards Tech. Paper* 93.) The curves for the other materials are for a thickness of 10 mm. (*Bur. Standards Sci. Paper* 404.)

occasionally as filters in motion-picture projectors to prevent the film from burning when it is not in motion. They are also used in photomicrography to prevent the slide from becoming overheated. One very effective type has been developed by Pfund. It consists of a sheet of glass coated with a thin layer of gold which, although it transmits approximately 80 per cent of the light from an incandescent lamp, absorbs all but about 20 per cent of the heat. This type of filter should strictly not be called heat absorbing because the infrared radiations are reflected rather than absorbed. There are other types of truly heat-absorbing filters, which are usually glasses in which ingredients have been incorporated to produce a high absorption in the infrared. These glasses are usually green in color. Since in this case the filter actually absorbs the heat, it may become so hot as to crack. To prevent this, some of the newer types are made from a glass having a low coefficient of expansion. For scientific purposes, such as photomicrography, a water cell is often used to absorb the heat, and the transmission curve for a 2-cm thickness is shown in Fig. 196. When water alone furnishes insufficient protection, there are many salts that may be added to

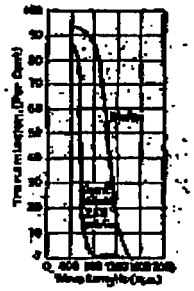

FIG. 196.